4.0 METHODS

4.1 Plowing and Surface Collection

The majority of the 1.07 ha (2.65 ac) wetland mitigation APE was plowed and disked. Following rain, a complete surface survey was conducted. Some of the barley on the southern end of the APE was not plowed, but surface visibility was nonetheless sufficient for survey. Indeed, most of the surface ceramics and lithic artifacts were recovered from the unplowed barley area. The locations of all surface finds were piece-plotted with a transit.

4.2 Unit Excavation

A metric grid was established with a transit, and datum stakes were placed at N100 E130 and N100 E349. A total of 21 1.0 x 1.0 m (3.3 x 3.3 ft) test units (1x1s) was excavated. All were excavated at least 20.0 cm (7.9 in) into sterile soils, and seven of the units were taken to 1.5 m (4.9 ft) below ground surface or to the point of groundwater seep. All soil was screened through 0.64 cm (0.25 in) mesh. Excavation was by 10.0 cm (3.9 in) arbitrary levels within soil strata. At least one profile of each completed unit was photographed and drawn to scale. All units were backfilled after the geomorphologist completed soil descriptions.

4.3 Geomorphological Description of Profiles

To assess the landforms and soils of the area, soil profiles from six unit excavations were examined and described according to the methods and nomenclature prescribed by the United States Department of Agriculture-Natural Resources Conservation Service (Schoenenberger *et al.* 2002). The descriptions are included in Appendix B.

Within soil descriptions, when a discontinuity in parent material is encountered with depth, a number prefix is added before the horizon designation of the differing parent material. The number increases with each change in parent material. The number "1" is not used.

4.4 Laboratory Methods

All recovered cultural material was bagged by provenience, assigned an FS (field specimen) number, and returned to Skelly and Loy, Inc.'s laboratory for processing and analysis. Once in the laboratory, all recovered artifacts were recorded, washed, and sorted by class, labeled, re-bagged by FS number, and submitted to the appropriate analyst. Only lithics and pre-contact ceramics were recovered, and they were analyzed according to the methods described below.

4.5 Lithic Analysis Methods

Binford (1987) suggests that the reconstruction of past behavior is best accomplished through the use of multiple lines of evidence. Lithic reduction and use sequences are complex and some ambiguity always exists in the interpretation of lithic artifacts and debitage. Therefore, the analysis presented here evaluates the lithic assemblage using both a typological approach and an evaluation of certain attributes (Ahler 1989; Bradbury and Carr 1994). Using both a typological and non-typological approach together can serve to strengthen inferences or support trends identified in a particular dataset.

The typology presented here is arranged in a logical sequence and concentrates on easily observable attributes thought to be diagnostic of particular reduction techniques. It relies on a hierarchical set of attributes that, while not mutually exclusive, if applied in sequence at least approach this state (Sullivan and Rozen 1985). The typological analysis is arranged in the following categories.

4.5.1 Flake Types

4.5.1.1 Non-diagnostic Shatter (NDS)

NDS lacks three essential elements of flakes: a platform remnant, a discernable dorsal and ventral surface, and a discernable axis of force application. NDS is sometimes called flake or block shatter and can be produced during any stage of the stone tool manufacturing sequence, though it is most common in the earlier stages of knapping. Large quantities of NDS are suggestive of initial reduction activities, raw material testing, or bipolar reduction (Sullivan and Rozen 1985; Warburton 1991).

4.5.1.2 Flake Fragments

Flake fragments lack a platform remnant and other attributes that allow them to be classified into a technological category and they cannot be employed to evaluate flaking technique. Recording them has utility, however, as some researchers (Magne 1989) suggest that the ratio of flakes that lack platform remnants to those that retain platform remnants (holding raw material constant) have implications for gross reduction states.

4.5.1.3 Indeterminate Flakes

Some flakes retain platform remnants but are otherwise not diagnostic. Therefore, these flakes cannot be employed to evaluate flaking technique.

4.5.1.4 Cortex Removal Flakes

Flakes produced early in the reduction process frequently exhibit large amounts of cortex on their dorsal surface, but otherwise lack attributes necessary to be typed into core or biface reduction sequences. Nevertheless, the presence of abundant cortex suggests that the flakes are diagnostic of the earliest stages of core reduction or tool production. These flakes are frequently called decortication flakes.

4.5.1.5 Core Trimming Flakes

These flakes are produced during the reduction of freehand cores. Within this general class, several additional categories are recognized.

Standard: These are generally mid-to-large-sized flakes with evidence of one to a few flake removals on their dorsal surface. The platform remnant is often flat or comprised of only a few flake scars. Sometimes, part or all of the platform remnant and dorsal surface is covered with cortex. The ventral surface often exhibits an acuminate or salient bulb of force from a hard hammer blow. These flakes were removed for the production of expedient or formal tools, to test for raw material quality, or may represent the initial stages of tool manufacture.

Bipolar: These flakes exhibit crushed or heavily battered platform remnants, frequently lack bulbs of force, and typically exhibit parallel (uni or bi-directional) flake scars on the dorsal surface (Jeske and Lurie 1993). These flakes are usually produced during the reduction of small pebble cores.

Blade: A flake at least twice as long as it is wide with evidence of at least two parallel flake scars on its dorsal surface is a blade (Greber *et al.* 1981). Where preserved, the platform remnant frequently exhibits evidence of preparation, including dragging, abrasion, or faceting (Bordes and Crabtree 1969). Such flakes are occasionally produced through simple core technologies. Where they exist in quantity, blades are evidence for a very specialized lithic reduction technique.

Core Rejuvenation: Typically, these flakes exhibit evidence of a large portion of core face preserved on their dorsal surface. Such flakes were often detached in an effort to remove large stacked hinge/step terminations or to rejuvenate a platform area for additional flake removals.

Janus: A flake removed from the ventral surface of another flake is a Janus flake (Inizan *et al.* 1992). The dorsal surface of a Janus flake consists of the bulb of force of the parent flake. More common in Old World technologies, such flakes are relatively rare or typically unrecognized by many analysts in eastern North America.

4.5.1.6 Biface Thinning Flakes

Biface thinning flakes are removed during the manufacture or resharpening of projectile points, bifaces, drills, and similar tools. Several sub-classes are recognized within the larger parent class.

Initial Edging: These flakes are diagnostic of the initial flaking of tabular slabs with squared edges or relatively flat chert cobbles with rounded edges (Towner and Warburton 1990). This flaking process is sometimes called "turning the edge" and the goal is to produce a biface edge where one did not exist, as a means to prepare for further reduction. This flake is asymmetric in plan view, contains some cortex, and has a platform remnant that usually consists of a single previous flake removal. This flake is sometimes called an "alternate" flake.

Standard: Flakes in this category are produced during mid-to-late stage biface thinning. The platform remnant frequently exhibits two or more flake scars and may exhibit evidence of preparation (dragging or abrasion). The platform remnant angle is usually much less than 90 degrees and may exhibit a "lip" on the ventral surface. Though not always produced during flaking, where found, a lip can usually be considered diagnostic of soft hammer reduction (Ohnuma and Bergman 1982). The dorsal surface exhibits several to numerous flake scars, while the ventral surface frequently exhibits a diffuse or gently expanding bulb of force. In cross section, the flake is thin and frequently curved.

Late Stage/Pressure: These flakes are generally produced during the final stages of stone tool manufacture or stone tool maintenance (Towner and Warburton 1990). Similar in size to uniface resharpening flakes (see below), late stage flakes are distinguished by a platform remnant that frequently exhibits one to several previous flake removals and has an angle of much less than 90 degrees. Flake scars on the dorsal surface can be either parallel or converging. The flake is always thin and frequently curved in cross section.

Notching: These flakes can be produced during either corner or side notching and is diagnostic of the production of a hafting element for a projectile point. Such flakes are small to minute but highly distinctive, almost always exhibiting a "half moon" shape in plan view. Platform remnants are similarly distinctive and exhibit a V-shape (Towner and Warburton 1990). Where found, these flakes most likely mark the location where final stage point manufacture occurred.

Edge Bite: This is a flake that is midway technologically between a biface and a biface thinning flake. These flakes are produced by a misapplication of force too far from the biface edge, resulting in a short but wide flake removal that represents a portion of biface edge.

4.5.1.7 Uniface Resharpening Flakes

These flakes are invariably small to minute, having been removed from the edge of endscrapers, sidescrapers, or other unifaces during manufacture or resharpening. Platform remnants are flat or nearly flat, forming an angle of close to 90 degrees with the dorsal surface. These flakes may exhibit moderate to severe abrasion at the juncture of the platform remnant and the dorsal surface; where found, this trait indicates the removal of the flake from the utilized margin of a uniface (Boldurian 1990). The dorsal surface usually exhibits two to four parallel negative flake scars. If the flake ends in a feathered termination, the distal end may exhibit a curvature, resulting from the flake terminating on the flat dorsal surface of the unifacial tool.

In rare instances, a very distinctive, long yet narrow uniface resharpening flake is identified. In this instance, the knapper desired to remove a sizable flake to rejuvenate a large portion of the working margin (Shafer 1970). To accomplish this, the knapper applied force to a margin adjacent to (perpendicular to) the working end, thus removing a long length of the working margin.

Flake Attributes

Flake attributes form a complimentary line of inquiry to the typological analysis presented above. While an infinite number of attributes could theoretically be recorded, the attributes below are particularly effective at elucidating various aspects of lithic reduction technology.

Platform Remnant Bearing (PRB): This attribute is recorded as absent or present. The relative proportion of PRB versus non-PRB flakes can serve as a rough indicator of lithic reduction methods (Magne 1989).

Cortex: Cortex refers to a tough outer rind of a raw material, developed through chemical and physical weathering. For bedded cherts, chemical weathering forms a rough "skin" on the outer surface of the rock. For cherts obtained from riverine or glacial deposits, physical weathering, and, to a lesser extent, chemical weathering, forms an extremely smooth weathering rind. During analysis of the lithic assemblage, four attribute states are recorded. Block cortex refers to the rough cortex characteristic of primary bedrock sources, while cobble refers to the smooth cortex characteristic of secondary sources. Absent refers to a complete lack of cortex, while present/indeterminate is used when the source (bedrock or cobble source) cannot be determined (because of variation inherent in all processes and because occasionally a patch of cortex is too small to evaluate). The presence, type, or absence of cortex is very useful in determining raw material procurement and provisioning strategies and has implications for artifact transport.

Flake Size: Size is recorded on a square template in the manner similar to Ahler (1989). The scale itself is divided into 10.0 mm (0.4 in) increments. Such a scale is useful because in large assemblages, it lends itself to certain statistical manipulations as both a "check" on the techno-typological analysis and for the evaluation of certain transformation processes at sites. In general, the smaller the flake the later the reduction stage.

Use: Macroscopic patterns of edge damage thought to be congruent with intentional use wear are noted.

Thermal Alteration: Lithic artifacts can be heated by a variety of processes. Intentional heat treatment serves to increase the workability of the material by rearranging the structure of the stone as observed under SEM microscopy. Heat treatment can be difficult to infer because natural processes like forest fires, as well as accidental introduction into campfires can heat flakes. Thus, three attribute states are noted. Absent refers simply to the absence of any identifiable heating. Heat damage refers to the presence of potlids, crazing, and stress fractures. Non-cultural processes or heat treating attempts gone awry are almost always responsible for these types of fractures. Present/Indeterminate is used in cases where heat alteration is noted but where there is no visible damage (potlids, crazing). These artifacts are seen as *potentially* representing intentionally heat-treated stone. Because of the variability in heating caused by a variety of factors, heat treating as such is typically inferred on the basis of comparison with experimental reproduction of chert artifacts and/or the demonstration that heating was associated with a certain class of flakes or tools.

4.5.2 Lithic Tool Types

4.5.2.1 Cores

Cores are simply nuclei from which flakes were detached. Two basic core types are recognized for analytical purposes, flake or freehand cores and biface cores (Boldurian 1990). Flake cores, also called multidirectional cores, have flake scars oriented in multiple directions. Bipolar cores exhibit uni-or bi- directional flake scars on one surface. These cores are formed when a piece of lithic raw material is seated on a stone anvil and struck with a hammerstone. Prepared cores (blade cores) are specimens that exhibit flake detachment from a single main striking platform. Flake scars on the surface of this core type are generally evenly spaced and parallel. Tested cobbles are lithic raw material whose quality was evaluated with the removal of one or several flakes. The purpose of the flake cores is for the production of flakes for use as simple unmodified tools (these have a sharp edge) or for the derivation of blanks intended for the manufacture of other tool types.

Biface cores or bifaces are different from flake cores--instead of producing flakes for use as tools, the biface itself was intended to be used as a tool or made into a tool (though the flakes removed from these items were occasionally used as expedient tools themselves). Bifaces can serve as tools during any stage of manufacture and, because of their large size, had a relatively long use-life, as a dulled edge could be quickly sharpened by the detachment of several flakes. Large bifaces can easily cut down small trees, serve as heavy-duty butchery tools, or as all purpose cutting implements. After many cycles of use/resharpening, the biface itself could be made into another tool (projectile point, drill, scraper).

Because of their specialized nature, biface cores are often separated into stages based on their degree of reduction; often, stages are based on the scheme of Callahan (1979). In this scheme, Stage 1 refers to raw material procurement and no bifaces are associated. Stage 2 (initial edging) bifaces exhibit incompletely flaked margins, frequently have cortex on one or more surfaces, and usually exhibit a wavy margin, the result of the deep flake scars associated with hard hammer reduction. Stage 3 (primary thinning) bifaces are flaked around their margins, have minimal or no cortex, have flake scars that travel to or near the midline, and frequently exhibit evidence of "soft hammer" flaking. Stage 4 (secondary thinning) bifaces are completely flaked and lack cortex. Flake scars meet at or traverse the midline of the piece. The biface appears flattened in cross section and soft hammer scars are typically in evidence. Stage 5 (shaping) bifaces, sometimes referred to as "preforms," exhibit flake scars that usually meet at, or more frequently, travel over the midline of the piece. Soft hammer flake scars cover the piece and pressure flake scars may be present along the margins of the biface. By this stage, any problems associated with earlier knapping (stacked hinge/step terminations, etc.) are generally absent from the biface. Depending on the requirements of the knapper, Stage 5 bifaces might be further reduced into another form, such as a projectile point. Indeterminate bifaces are generally fragments too small in size to allow for a confident determination of stage or type.

In addition to bifaces in various stages of reduction, the general "biface" category also includes forms such as projectile points. Projectile points, despite what the name implies, were used both as projectiles and as general purpose cutting tools for game butchery and other tasks (Ahler 1971). Drills are bifaces with an extremely narrow blade employed for the purpose of puncturing or drilling objects. Hafted scrapers are generally projectile points whose blades were broken and modified into a scraping edge.

4.5.2.2 Unifaces

Unifaces are tools that exhibit flaking on one face only. Endscrapers exhibit a steep-angled distal working margin used for the purpose of hide preparation or woodworking. Sidescrapers perform a function similar to endscrapers: however, they are modified on one lateral margin. Gravers are flakes with a tiny projecting ear frequently used as a punch for hide working. Retouched flakes exhibit modification on one or more working margins but lack the formal shape of end or side-scrapers or gravers. Retouched flakes were employed for a variety of tasks.

4.6 Ceramic Analysis

Ceramics were described by temper (judged with a 10X power hand lens) and surface decoration. The resultant classes were compared to regional type descriptions (e.g., Griffith 1982), and tentative assignments were reviewed in person with Dr. Daniel Griffith of the Delaware SHPO. An insufficient number of sherds was recovered to support any formal/functional or minimum vessel analyses.